Identifying small-for-gestational-age preterm infants from the Finnish Medical Birth Register using eight growth charts

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Fetal growth restriction (FGR) is a major risk factor for infant mortality and morbidity and adverse lifelong developmental, mental and physical health outcomes. It is usually studied using small for gestational age (SGA), which is most commonly defined as a weight under the 10th percentile based on growth charts. Identifying infants with SGA is necessary for research on the long-term consequences of perinatal pathologies and particularly important for children born preterm. Early onset FGR, which has been associated with preterm birth, incurs higher risks than later onset FGR and is a prognostic factor for poor cognitive development, respiratory morbidity and metabolic disorders.

Growth charts to identify SGA infants use different conceptual approaches and methods, reflecting ongoing debate on three key questions. First, should charts be constructed from birthweights or fetal weights estimated from ultrasound measurements (abdominal and head circumference and femur length)? Preterm infants are more likely to have growth anomalies and charts established from birthweights will have have lower percentiles than intrauterine charts established from estimated fetal weights in on-going pregnancies. Therefore, the 10th percentile will be lower and some infants at risk for complications due to poor growth may be missed. Second, is it possible to develop universal standards for healthy growth or should charts be based on national references? Third, do customised charts, which adjust growth trajectories for individual maternal and fetal factors that physiologically affect growth, including sex and maternal height, provide added value?

Our aim was to describe the differences in SGA classifications when using national and international intrauterine and birthweight charts in Finland.

We included live infants born with a birthweight ≥500 grams, or a GA ≥22 weeks, recorded in the Finnish Medical Birth Register in 2006-2016. The data collected included birthweight, GA in weeks and days, calculated from last menstrual period and confirmed by ultrasound, sex and variables for deriving customised charts (maternal height, pre-pregnancy weight,
parity and smoking). We used two SGA definitions: birthweight <10\(^{th}\) percentile and <2 standard deviations.\(^4\) We identified 37,257 preterm births before 37 weeks of GA. There were 26,891 once we had excluded births <24 weeks, multiple births, missing birthweights or GA and discordant birthweights for GA (<300g or Z-score <6 or >4 standard deviations).

Our literature review identified the eight growth charts most commonly used to examine intrauterine growth and health: two intrauterine standards (World Health Organization, Intergrowth intrauterine), two intrauterine references (Maršál, Hadlock), one birthweight standard (Intergrowth birthweight), two birthweight references (Sankilampi, Fenton) and the customised GROW chart (Table S1). Most are sex-specific, except Intergrowth intrauterine and Hadlock; Sankilampi has separate charts for primiparous and multiparous births. We used each chart to calculate the percentage of preterm SGA infants by GA, grouped in two week categories.

The proportions of preterm SGA births were: Fenton (7.6%), Intergrowth birthweight (9.3%), Intergrowth intrauterine (11.8%), customised (17.2%), Hadlock (20.3%), Sankilampi (21.8%), World Health Organization (22.3%) and Maršál (22.6%). SGA births varied between charts and across gestations (Figure 1) with most variation at 28-29 weeks: 9.1%-29.8% for the birthweight charts, 31.3%-47.7% for the intrauterine charts and 33.9% for the customised chart. The absolute differences between the fetal and birthweight charts were highest at these GA, then declined. The proportions after 34 weeks ranged from 13.8%-20.9%, except for the Fenton (7.3%), Intergrowth intrauterine (8.5%) and Intergrowth birthweight (8.6%) charts. The Fenton and Intergrowth birthweight charts systematically provided lower SGA proportions across GA than the other charts. Patterns were similar using the threshold of -2SD, with a range of 1.9%-11.2% (Figure S1).

There were large differences in how the eight charts classified SGA, particularly for the intrauterine and birthweight charts at 28-32 weeks of GA. This may reflect more induced
deliveries for early onset FGR at these gestations. We also observed differences between national and international charts, as Fenton and the intergrowth charts provided lower SGA proportions than the Nordic charts. This suggests that the international charts may not accurately describe Finnish birthweight distributions. Other studies have also shown that Intergrowth charts underestimated SGA in Nordic countries.⁵

These results highlight the importance of choosing the right chart when quantifying FGR in preterm births, and suggest that using the 10th percentile threshold with international or birthweight charts may underestimate how many children risk adverse outcomes due to growth impairment, in particular those born at 28-32 weeks of GA. Using different charts also makes it difficult to compare research findings. The charts used in FGR research should be detailed in papers, so that meta-analyses can assess any impact on their findings. More prospective studies on neonatal and long-term outcomes are needed to provide evidence on the best charts to use. These should include the threshold for monitoring FGR in children born preterm.

ABBREVIATIONS

FGR, fetal growth restriction; SGA, small for gestational age; GA, gestational age

CONFLICTS OF INTEREST

No conflict of interest to declare.

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DATA AVAILABILITY STATEMENT
Individual participant data are not available. Growth chart data are available in referenced publications.

REFERENCES


**Supplementary Table 1: Publications used to construct each chart**

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Supplementary Figure 1: Values for the -2SD threshold and proportions of infants with a birthweight under -2SD by gestational age according to eight growth charts

**Boys**

**Girls**

NOTE: The threshold of -1.96 SD is represented for WHO

Intergrowth birthweight charts were obtained from two different publications: one for births before 33+0 weeks of gestation and one after